JHR 98: 419–433 (2025)
doi: 10.3897/jhr.98.144997
https://jhr.pensoft.net

RESEARCH ARTICLE

JOURNAL OF Hymenoptera RESEARCH
A peer-reviewed open-access journal
The International Society of Hymenopterists

Is the spread of *Wasmannia auropunctata* (Hymenoptera, Formicidae) through the western Palearctic inevitable? First evidence of presence in the Canary Islands

Antonio José Pérez-Delgado[1], Irene Santos-Perdomo[1], Eduardo Jiménez-García[2], David Lugo[2], Daniel Suárez[2]

1 *Island Ecology and Evolution Research Group, Instituto de Productos Naturales y Agrobiología (IPNA-CSIC), 38206, San Cristóbal de La Laguna, Tenerife, Spain* **2** *Departamento de Biología Animal, Edafología y Geología, University of La Laguna, 38200, San Cristóbal de La Laguna, Tenerife, Spain*

Corresponding author: Antonio José Pérez-Delgado (ajperez@ipna.csic.es)

Academic editor: Francisco Hita Garcia | Received 23 December 2024 | Accepted 1 March 2025 | Published 3 April 2025

https://zoobank.org/B111A625-9A46-462D-8C35-07DCAFD27C80

Citation: Pérez-Delgado AJ, Santos-Perdomo I, Jiménez-García E, Lugo D, Suárez D (2025) Is the spread of *Wasmannia auropunctata* (Hymenoptera, Formicidae) through the western Palearctic inevitable? First evidence of presence in the Canary Islands. Journal of Hymenoptera Research 98: 419–433. https://doi.org/10.3897/jhr.98.144997

Abstract

Wasmannia auropunctata, also known as the 'little fire ant' or 'electric ant', is an invasive species that represents a serious threat to biodiversity and public health globally due to its intrinsic characteristics and low detectability. Here, through a combination of morphological and molecular identification, the first record of this species in the oceanic archipelago of the Canary Islands is presented. Molecular data reveal that the population from the Canary Islands is completely different from another population established in Málaga (mainland Spain), which suggests that the western Palearctic has been colonised from at least two independent events. The early detection of this species in a very limited area provides an important temporal window for its eradication and the prevention of its dispersal to other areas.

Keywords

Barcoding, early detection, invasive ant species, little fire ant, oceanic islands

Copyright *Antonio José Pérez-Delgado et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Introduction

Invasive alien species (IAS) are species introduced outside of their natural distribution range that have negative impacts on native communities. IAS are among the greatest global threats to biodiversity, but also to human economy and health (e.g., Reaser et al. 2007; Early et al. 2016; Paini et al. 2016). Social insects, especially ants, are among the worst invaders worldwide (Bertelsmeier 2021; Gruber et al. 2021; Angulo et al. 2022; Tercel et al. 2023). Impacts driven by invasive ants include the reduction of abundance and richness of animal species in undisturbed natural systems (Tercel et al. 2023 and references therein); alteration of ecosystem functions such as scavenging and nutrient cycling (e.g. Angulo et al. 2011; Holway and Cameron 2021; Turner et al. 2021); negative effects on plant-animal mutualisms (e.g., Davis et al. 2010; Fagua and Ackerman 2011; Hansen and Müller 2009; Sinu et al. 2017); effects on human health (Rosselli and Wetterer 2017; Lopez et al. 2024), and high economic costs to mitigate their effects (Gruber et al. 2021; Angulo et al. 2022). A meta-analysis conducted by Angulo et al. (2022), comprising more than 1,300 cases of 12 invasive ant species in 27 countries, since 1930, estimated the economic costs of US$ 51.93 billion to mitigate their impact.

Due to their small size, their generalist nesting habits and frequent association with disturbance environments or habitat, ants are often accidentally transported by humans in goods, mainly together with live plants, wood, soil, litter, etc. (Suarez et al. 2010; Fournier et al. 2019; Suhr et al. 2019; Bertelsmeier 2021). Biological invasions are becoming more frequent due to the recent increase in human trade and tourism, which has resulted in more than 200 species of ants introduced worldwide (Suarez et al. 2010). The early detection and rapid response to the invasive species is considered a first principle of effective and cost-efficient strategies to address invasive species (Rease 2020), followed by subsequent local eradication to prevent range expansion. The faster the response is carried out, the more probabilities for a population to be eradicated (Lodge et al. 2006). In general, the larger the population, area, and coverage, the more limited the possible response options are (Simberloff 2003). Thus, the window of opportunity for potential successful eradication is narrow (Martinez et al. 2020). A key aspect to highlight is that post-invasion management costs greatly exceed those dedicated for pre-invasion management measures, being approximately twenty times higher (Angulo et al. 2022). Early detection and rapid response have allowed local eradications of ant populations worldwide, such as *Solenopsis invicta* in New Zealand and specific populations in Australia (Christian 2009; Wylie et al. 2016), *Pheidole megacephala* (Fabricius, 1793) in Australia (Hoffmann et al. 2010; Hoffmann 2011), *Solenopsis geminata* (Fabricius, 1804) in Australia and Hawaii (Hoffmann et al. 2011), or *Wasmannia auropunctata* (Roger, 1863) in Australia, the island of Marchena (Galápagos) and specific populations in Hawaii (Causton et al. 2005; Vanderwoude et al. 2010). In terms of area, the largest successful ant eradication was that of *S. invicta* that covered 8,300 ha in the port and airport of Brisbane, Australia (Wylie et al. 2016). However, the mean area eradicated is much smaller 68 ha, with more than 60 % of the reported cases being conducted in less than 2 ha (Hoffman et al. 2016).

Commonly named as the 'little fire ant' or 'electric ant', *Wasmannia auropunctata* is one of the worst invasive ant species worldwide (Angulo et al. 2022) being included in

the IUCN Global Invasive Species Database (GISD) (ISSG 2015), as well as in the list of invasive alien species of concern to the European Union (Commission Implementing Regulation (EU) 2022/1203 of July 12, 2022). Several impacts have been reported associated with *W. auropunctata* such as displacing native ant species, reducing invertebrate populations, harming wild and domestic vertebrates and even humans (Montgomery et al. 2022 and references therein). *Wasmannia auropunctata* is recognised as an extremely serious socioeconomic threat (Gruber et al. 2021), being the second ant species with the highest economic cost reported worldwide (US$ 7.35 billion; Angulo et al. 2022). Several characteristics contribute to its invasive success in new environments: generalist diet; ability to establish in a variety of habitat types; supercolonial social structure; polygyny; clonal reproduction in invasive populations; and, association with human-modified habitats (Wetterer 2013; Montgomery et al. 2022). This species is native to South and Central America, but due to human activity, its distribution has expanded to at least 31 countries and islands worldwide, mainly in tropical and subtropical areas (Wetterer 2013; Montgomery et al. 2022; Hsu et al. 2022; Demetriou et al. 2022; Blight et al. 2023). In the recent years, *W. auropunctata* has spread through the western Palearctic region, being found both indoor in Germany (Geiter et al. 2002; exotic indoor), and the Netherlands (Boer and Vierbergen 2008; several findings during port inspections but without establishment), as well as outdoors Israel (Vonshak et al. 2010), mainland Spain (Espadaler et al. 2018), Cyprus (Demetriou et al. 2022), and France (Blight et al. 2023). The Mediterranean basin is so far the only area where there are outdoor records of the species in temperate climate.

Here, we provide the first record of *Wasmannia auropunctata*, for the Canary Islands, as well as discuss the problematic of the species based on the available information.

Material and methods

The Canary Islands are a volcanic archipelago of seven islands located in the eastern-mid Atlantic Ocean between coordinates 27°37'N and 29°25'N and 13°20'W and 18°10'W, 96 km off the coast of Morocco. Together with four other archipelagos (Azores, Madeira, Savage Islands and Cape Verde), they comprise the biogeographic region of Macaronesia. These archipelagos contribute significantly to the number of unique species in the biodiversity hotspot of the Mediterranean basin (Myers et al. 2000). The Canary archipelago is the most prominent with 40.3% of its fauna and 22.4% of its flora being endemic (Gobierno de Canarias 2024), highlighting the importance of this region in the biogeographical area of the Mediterranean basin. To date, the myrmecofauna of the Canary Islands is represented by 61 ant species and subspecies, of which 19 are endemic, 16 are native, and 26 are exotic to the archipelago (Gobierno de Canarias 2024; Suppl. material 1: table S1). In order to know the biodiversity and distribution of exotic and native ant species, since 2016, more than 1,300 sampling location have been sampled recording of which almost 69% are anthropogenic environments, areas that are more susceptible to the arrival of exotic species (Hernández-Teixidor et al 2020; Pérez-Delgado unpublished data).

In August 2023, in collaboration with a study on the diet (identification of arthropods in stomach contents) of the introduced lizard *Anolis porcatus* Gray, 1840 on a golf course

in the south of island of Tenerife, some ant fragments (head and mesosoma) were detected that did not fit with any of the species reported for the Canary Islands (Antweb images http://www.antweb.org; Pérez-Delgado personal collection reference material). Four visits were made (August and September, 2023; August and November, 2024) to the gardens surrounding the golf course and other gardens within the townships. Individuals were collected for morphological identification and subsequent verification by DNA barcoding.

Morphological identification

Individuals were examined under a Zeiss Stemi 2000 stereomicroscope. Identification at species-level was conducted using taxonomic keys (Longino and Fernández 2007) and Antweb images (http://www.antweb.org). Microscopic images of the habitus were taken using a Canon EOS-750D camera and stacked with Zerene Stacker (Zerene Systems LLC. version 1.04).

Molecular identification

In order to confirm the identification, DNA barcoding was carried out at the Genomic Diversity Service of the Instituto de Productos Naturales y Agrobiología (Spanish National Research Council). DNA was extracted from two specimens with the Mag-Bind Blood & Tissue DNA HDQ 96 kit (Omega Bio-Tek GA, USA) using a KingFisher Flex (Thermofisher), and DNA concentrations were measured using Tecan Infinite 200 Pro (Configuration: Infinite M Nano+). The 5' region (658 bp) of the mtDNA COI gene was amplified using FoldF and FoldR primers (Yu et al. 2012). PCR reaction conditions were as follows: initial denaturation at 95 °C for 4 min, followed by 40 cycles of 94 °C for 45 s, 47 °C for 45 s, and 72 °C for 90 s, and a final extension of 72 °C for 10 min. A volume of 2 µL of diluted DNA extract was amplified with 18 µL of PCR mix (for a total volume of 20 µL), comprised of 12.7 µL of water, 2 µL of 10× NH_4 buffer, 1.2 µL of 50 mM $MgCl_2$, 0.4 µL of 10 mM dNTPs, 0.4 µL of BSA (20 mg/ml), 0.6 µL of each primer (10 µM), and 0.1 µL of Taq polymerase (BIOTAQ). PCR products were sequenced using the Sanger DNA sequencing service of Macrogen (www.macrogen.com). Sequences were then edited in Geneious 2021.1.1 (www.geneious.com). Molecular identification was assessed using the Barcode of Life Data Systems (BOLD Systems) identification engine. A dataset was assembled including our sequenced barcode and a set of barcode sequences including all available haplotypes and countries. A Maximum Likelihood phylogenetic tree was built using RAxML 8.2.11 (Stamatakis 2014).

Results

The first specimens of *W. auropunctata* were detected in the stomach contents of *Anolis porcatus* from the interior of a golf course and in the surrounding gardens (28°3.750'N, 16°43.235'W). Subsequent visits have been made to the surrounding

gardens, where areas with a high abundance of workers but only two nests were found. Although it should be noted that it was not possible to sample inside the golf course. Five other ant species were detected during these sampling (Suppl. material 1: table S1), but the only one near the *W. auropunctata* nests was *Brachymyrmex cordemoyi* Forel, 1895.

Morphological identification

Individuals were identified as *Wasmannia auropunctata* unequivocally, which is distinguished by several distinctive features of workers: small ant (1–2 mm total length), monomorphic, pronounced frontal carinae that extend to the back of the head and form the prominent antennal scrobes, the antennae have 11 segmented and a 2-segment apical club; large propodeal spines; and the convex mesosoma which lacks a mesonotal suture (Fig. 1).

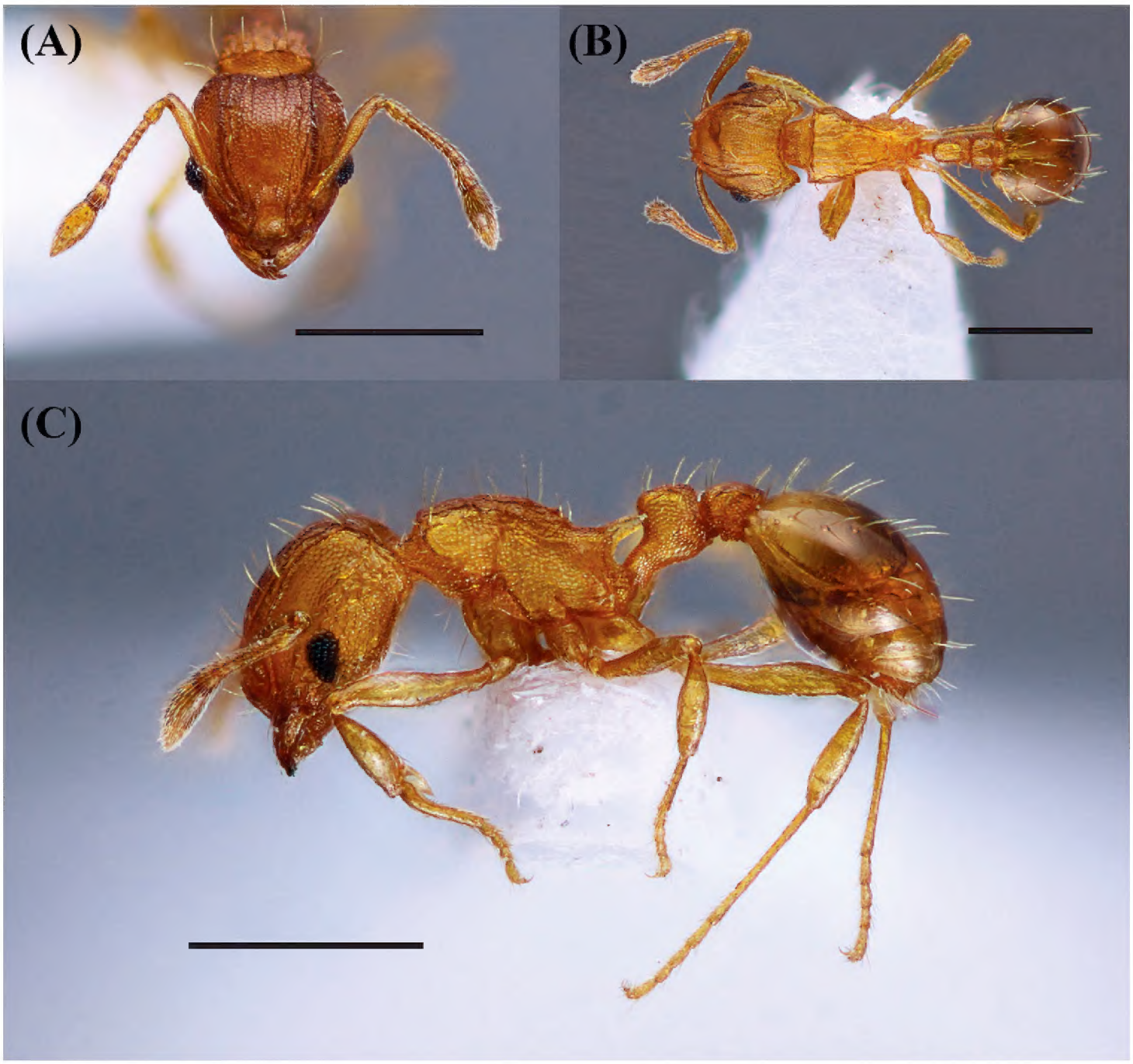

Figure 1. *Wasmannia auropunctata* worker, head (**A**), dorsal (**B**), and lateral (**C**) views. Scale bars: 0.5 mm.

Molecular identification

Two 619-bp sequences with no ambiguities were obtained (GenBank accession numbers PQ629112–PQ629113). Sequences were 99.5% identical to sequences identified as *W. auropunctata* from Ecuador (PREEC1745-22 and FROGB105-16). Sequences were clustered into a group comprising sequences from Ecuador and Peru. There was just an available sequence from the western Palearctic, being this sequence generated from a sample from Málaga (Spain; ANTEU4632-22). This sequence was 100 % identical to a sequence from Argentina (ANTI521-16) and was placed within a group comprising sequences from Argentina and Gabon. Mainland Spain and Canary Islands sequences displayed a similarity of 91.3% (Fig. 2).

Discussion

Genetic and morphological analyses have confirmed the presence of *Wasmannia auropunctata* in Tenerife, thus expanding its known distribution in the western Palaearctic. Globalisation and the massive movement of goods have meant that goods are not always subject to effective customs inspections (Perrings et al. 2010). This has allowed the rapid range expansion through the transport of ant-infested agricultural, horticultural and construction materials (Suarez et al. 2010; Suhr et al. 2019; Bertelsmeier 2021). This species has experienced an increase in its distribution worldwide, with 53.8 % of records at countries and islands levels occurring in the last 25 years (Wetterer 2013; Demetriou et al. 2022; Hsu et al. 2022; Montgomery et al. 2022; Blight et al. 2023). The first outdoor report for this species in a temperate climate area was in 2009 (Vonshak et al. 2010), as previous records in this area had occurred in greenhouses. Genetic results show that, at least, two independent colonisations have occurred in the western Palearctic. This is supported by the high genetic divergences between Tenerife and Málaga populations (8.7 %), and the fact that they were not placed within the same phylogenetic group (Fig. 2). This high divergence substantially exceeds what is typically considered to be found within species (Ratnasingham and Hebert 2013), suggestive of either cryptic or undetected species within what has been described as *W. auropunctata*. We also highlight the lack of genetic information of this species from introduced areas, especially in the western Palaearctic, as of the six already known established populations, there is only available barcode data for one population (Málaga, mainland Spain). This genetic information would be crucial to manage the expansion of *W. auropunctata* as it would allow knowing the origin of each of the populations and focus efforts on the potential entry routes of the species.

Although all regions of the planet are suffering impacts derived from biological invasions, these impacts in insular ecosystems can be exacerbated due to the vulnerability of island ecosystems to invasive species (Reaser et al. 2007; Bellard et al. 2017). About 43 % of the ant species reported for the Canary Islands are considered exotic (Schifani et al. 2018; Staab 2019; Hernández-Teixidor et al. 2020), and seven of them are recorded in the IUCN list of invasive species (ISSG 2015; Suppl. material 1: table S1). Those seven

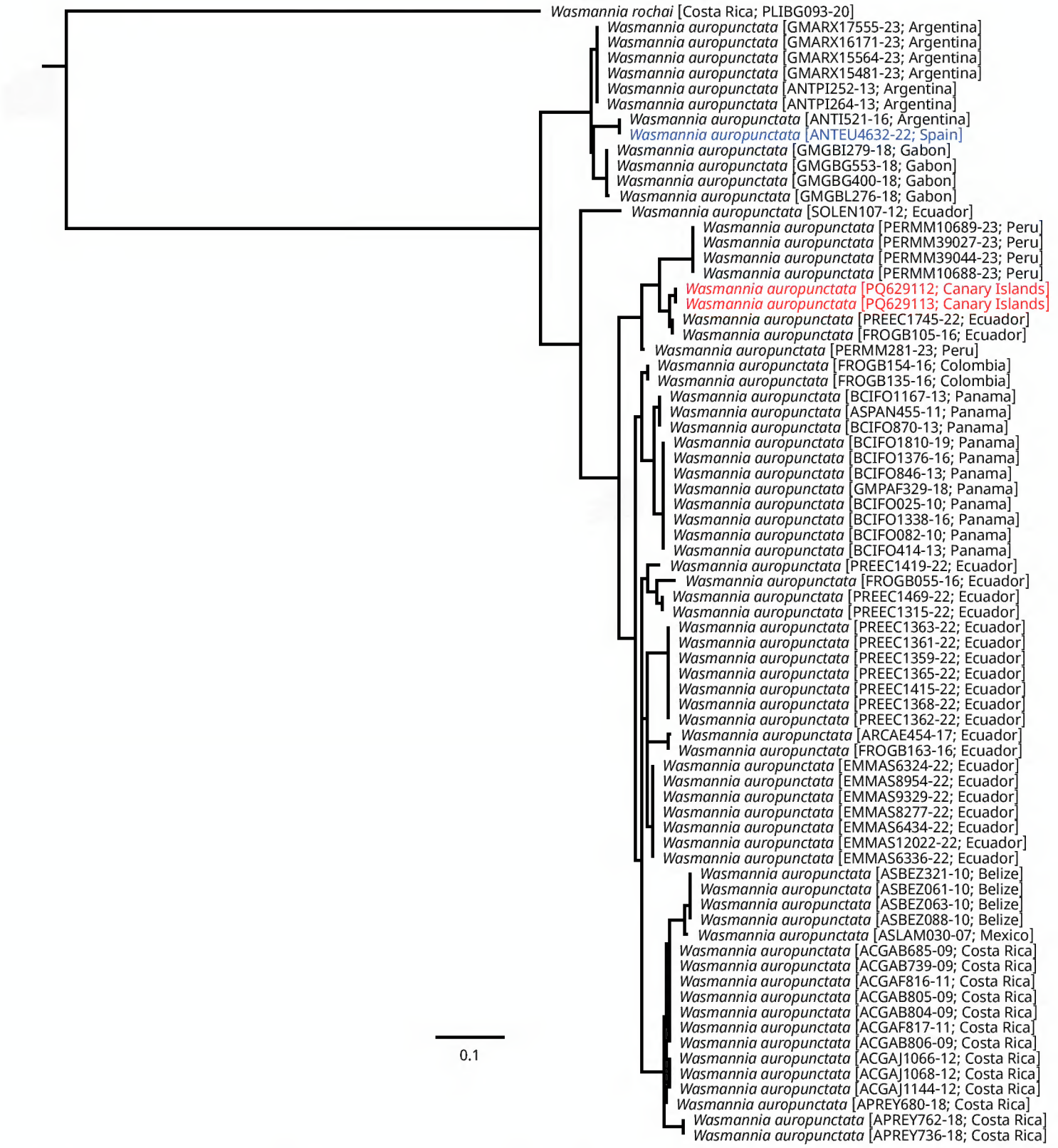
Wasmannia rochai [Costa Rica; PLIBG093-20]
Wasmannia auropunctata [GMARX17555-23; Argentina]
Wasmannia auropunctata [GMARX16171-23; Argentina]
Wasmannia auropunctata [GMARX15564-23; Argentina]
Wasmannia auropunctata [GMARX15481-23; Argentina]
Wasmannia auropunctata [ANTPI252-13; Argentina]
Wasmannia auropunctata [ANTPI264-13; Argentina]
Wasmannia auropunctata [ANTI521-16; Argentina]
Wasmannia auropunctata [ANTEU4632-22; Spain]
Wasmannia auropunctata [GMGBI279-18; Gabon]
Wasmannia auropunctata [GMGBG553-18; Gabon]
Wasmannia auropunctata [GMGBG400-18; Gabon]
Wasmannia auropunctata [GMGBL276-18; Gabon]
Wasmannia auropunctata [SOLEN107-12; Ecuador]
Wasmannia auropunctata [PERMM10689-23; Peru]
Wasmannia auropunctata [PERMM39027-23; Peru]
Wasmannia auropunctata [PERMM39044-23; Peru]
Wasmannia auropunctata [PERMM10688-23; Peru]
Wasmannia auropunctata [PQ629112; Canary Islands]
Wasmannia auropunctata [PQ629113; Canary Islands]
Wasmannia auropunctata [PREEC1745-22; Ecuador]
Wasmannia auropunctata [FROGB105-16; Ecuador]
Wasmannia auropunctata [PERMM281-23; Peru]
Wasmannia auropunctata [FROGB154-16; Colombia]
Wasmannia auropunctata [FROGB135-16; Colombia]
Wasmannia auropunctata [BCIFO1167-13; Panama]
Wasmannia auropunctata [ASPAN455-11; Panama]
Wasmannia auropunctata [BCIFO870-13; Panama]
Wasmannia auropunctata [BCIFO1810-19; Panama]
Wasmannia auropunctata [BCIFO1376-16; Panama]
Wasmannia auropunctata [BCIFO846-13; Panama]
Wasmannia auropunctata [GMPAF329-18; Panama]
Wasmannia auropunctata [BCIFO025-10; Panama]
Wasmannia auropunctata [BCIFO1338-16; Panama]
Wasmannia auropunctata [BCIFO082-10; Panama]
Wasmannia auropunctata [BCIFO414-13; Panama]
Wasmannia auropunctata [PREEC1419-22; Ecuador]
Wasmannia auropunctata [FROGB055-16; Ecuador]
Wasmannia auropunctata [PREEC1469-22; Ecuador]
Wasmannia auropunctata [PREEC1315-22; Ecuador]
Wasmannia auropunctata [PREEC1363-22; Ecuador]
Wasmannia auropunctata [PREEC1361-22; Ecuador]
Wasmannia auropunctata [PREEC1359-22; Ecuador]
Wasmannia auropunctata [PREEC1365-22; Ecuador]
Wasmannia auropunctata [PREEC1415-22; Ecuador]
Wasmannia auropunctata [PREEC1368-22; Ecuador]
Wasmannia auropunctata [PREEC1362-22; Ecuador]
Wasmannia auropunctata [ARCAE454-17; Ecuador]
Wasmannia auropunctata [FROGB163-16; Ecuador]
Wasmannia auropunctata [EMMAS6324-22; Ecuador]
Wasmannia auropunctata [EMMAS8954-22; Ecuador]
Wasmannia auropunctata [EMMAS9329-22; Ecuador]
Wasmannia auropunctata [EMMAS8277-22; Ecuador]
Wasmannia auropunctata [EMMAS6434-22; Ecuador]
Wasmannia auropunctata [EMMAS12022-22; Ecuador]
Wasmannia auropunctata [EMMAS6336-22; Ecuador]
Wasmannia auropunctata [ASBEZ321-10; Belize]
Wasmannia auropunctata [ASBEZ061-10; Belize]
Wasmannia auropunctata [ASBEZ063-10; Belize]
Wasmannia auropunctata [ASBEZ088-10; Belize]
Wasmannia auropunctata [ASLAM030-07; Mexico]
Wasmannia auropunctata [ACGAB685-09; Costa Rica]
Wasmannia auropunctata [ACGAB739-09; Costa Rica]
Wasmannia auropunctata [ACGAF816-11; Costa Rica]
Wasmannia auropunctata [ACGAB805-09; Costa Rica]
Wasmannia auropunctata [ACGAB804-09; Costa Rica]
Wasmannia auropunctata [ACGAF817-11; Costa Rica]
Wasmannia auropunctata [ACGAB806-09; Costa Rica]
Wasmannia auropunctata [ACGAJ1066-12; Costa Rica]
Wasmannia auropunctata [ACGAJ1068-12; Costa Rica]
Wasmannia auropunctata [ACGAJ1144-12; Costa Rica]
Wasmannia auropunctata [APREY680-18; Costa Rica]
Wasmannia auropunctata [APREY762-18; Costa Rica]
Wasmannia auropunctata [APREY736-18; Costa Rica]
0.1

Figure 2. Maximum-likelihood tree showing the phylogenetic placement of *Wasmannia auropunctata* based on the mitochondrial data set (cox1) from a sample of 74 individuals and 619-bp DNA sequences. BOLD accession numbers and countries in brackets. Reference sequence codes correspond to GenBank accession numbers. *Wasmannia rochai* was used as an outgroup in the analysis. Red = specimens sequenced in this study (Canary Island). Blue = sequence from Málaga (mainland Spain).

species are widespread worldwide and produce serious impacts for human goods and notable effects on ecosystems (e.g., Wetterer et al. 1999; Plentovich et al. 2009; Wetterer 2010, 2012; Boase 2014; Zhou et al. 2014; Montgomery et al. 2022; Angulo et al. 2024). *Wasmannia auropunctata* like other tramp species, has characteristics that are key to its invasive success, such as high rates of polygyny, high interspecific aggressiveness, high density of individual, and colony foundation by budding instead of nuptial

flights (Passera 1994; Holway et al. 2002; Heinze et al. 2006). However, there are two key aspects of its invasive potential. Firstly, outside its natural range, *W. auropunctata* builds supercolonies that can extend hundreds of kilometres, with multiple interconnected nests that exhibit low intraspecific aggression between workers from distant areas (Breton et al. 2004; Montgomery et al. 2022). This behaviour allows population growth, reaching estimated densities of more than 20,000 workers/m^2 of which 40 will be queens (Souza et al. 2008). This population is larger than the estimate for *Solenopsis invicta* with 2,000–4,000 workers/m^2 (Macom and Porter 1996) and may be one of the largest of all ant species in the world (Montgomery et al. 2022). This high density of individuals is one of the main causes of the environmental and economic problem posed by *W. auropunctata* outside its native range. Secondly, while natural populations in conserved environments show a haplodiploid reproductive system typical of Hymenoptera, the populations in disturbed and introduced areas consist in queens produced by thelytokous parthenogenesis, and males generated by a male clonality system (Fournier et al. 2005; Foucaud et al. 2007). This unusual reproductive strategy seems to be a key factor in the successful establishment of small founder colonies (Mikheyev et al. 2009). In general, the genetic diversity of the founding population is low because few individuals arrive and reproduce (Lawson et al. 2011). This may lead to genetic bottleneck, causing inbreeding and loss of heterozygosity leading to loss of fitness (Dlugosch and Parker 2008). However, the reproductive strategy of *W. auropunctata* allows for the preservation of heterozygosity when genetic diversity is low and avoids the consequences of inbreeding (Foucaud et al. 2007; Rey et al. 2013). It is likely that this clonal reproductive system is responsible for the success of *W. auropunctata* in human-modified habitats (Montgomery et al. 2022) and contributes significantly to its invasive potential.

Given the ecological and economic problems of this species, eradication programs have been proposed worldwide for controlling early-detected populations (e.g., Espadaler et al. 2018; Blight et al. 2023; Wang et al. 2024). There are, however, some examples of local eradications of *W. auropunctata.* In Marchena island (Galápagos archipelago, Ecuador) the species was eradicated from an area of 21 ha (Causton et al. 2005). In the Hawaiian archipelago there are also several examples of local population detection and eradication. Conant and Hirayama (2000) reported *W. auropunctata* for the first time in 1999 for the islands of Hawaii (Big Island), Maui, Kauai and Oahu. Since then, due to the existence of monitoring plans, new populations have been found, resulting from the involuntary transport from infected areas within the same archipelago (Vanderwoude et al. 2016). The spread of *W. auropunctata* throughout the Hawaiian Islands is likely to have significant economic and ecological repercussions. The projected economic costs for the Big Island alone are likely to exceed U$100 million annually (Vanderwoude et al. 2016). *W. auropunctata* management in the Hawaiian archipelago is estimated to cost US$ 6.1 billion over 35 years if current management efforts are maintained (Lee et al. 2015). However, if current management is not maintained the cost could be increased slightly more than double (US$ 12.9 billion). In contrast, with improved prevention actions, rapid response to newly detected infestations and enhanced management, the cost could be reduced to US$ 51 million over 35 years (Lee et al. 2015).

In our case study, *W. auropunctata* has so far only been found in an urban garden area with an estimated maximum area of no more than 55 ha (i.e., the area of the golf course and surrounding gardens). However, to correctly delimit the extent of this population it is necessary to prospect inside the golf course and to intensify sampling in other garden areas of the township. The golf course is located in one of the most important tourist townships within Tenerife, with a high population density (2,263 inhabitants/km^2) and with abundant garden areas and one of the most important ports of the Canary Islands with a daily traffic of more than 1300 vehicles (https://www.puertos-detenerife.org/memorias-anuales/). Although intensive sampling has been carried out since 2016 within the Canary Islands (Hernández-Teixidor et al. 2020; Pérez-Delgado unpublished data), *W. auropunctata* has not been detected anywhere else. However, due to the characteristics of the species (body size and behaviour) its potential presence in other localities should not be ruled out. As this golf course hadn't been sampled before, we cannot firmly state that this record constitutes a very recent colonisation (i.e., months or a couple of years). However, based on available data (Hernández-Teixidor et al. 2020; Pérez-Delgado unpublished data), its current distribution seems to be restricted to the golf course and its surroundings in Tenerife Island. All these suggest that control and eradication measures should be taken as soon as possible in order to avoid *W. auropunctata* spreading throughout the island or reaching other islands of the archipelago, which could pose a risk to biodiversity and a potentially high socio-economic cost. In addition, effective biosurveillance systems are needed to detect the transport of the species and reduce the gap between arrival and detection of the species.

Author contributions

AJP-D conceived the study. AJP-D, EJ-G, DL conducted fieldwork. AJP-D, DS performed the genetic analysis. All authors contributed to writing and editing the manuscript.

Acknowledgments

We thank Aarón González and Juan Carlos Rando (University of La Laguna) for providing the specimens of *Wasmannia auropunctata* obtained in the analysis of the diet of *Anolis porcatus*. We would like to thank the RedExos (GESPLAN) fieldwork team for collecting samples of *Anolis porcatus*. We would also like to thank Brent C. Emerson for allowing us to use the facilities of the Genomic Diversity Service to carry out the molecular analyses and to contribute comments and suggestions for the improvement of the manuscript. The DNA barcoding was carried out in the framework of the project 'CanaryBarcode: towards the genomic inventory of the biodiversity of the Canary Islands', funded by the Agencia Canaria de Investigación, Innovación y Sociedad de la Información (ACIISI), Gobierno de Canarias (ProID2021010093), awarded to Brent C. Emerson. David Lugo was funded by 'Agencia Canaria de Investigación, Innovación y Sociedad de la Información'

(ACIISI), with 'Fondo Social Europeo Plus' (FSE Plus) 2021–2027 funds through FPI PhD fellowship (FPI2024010117). Irene Santos-Perdomo was cofunded by the 'Agencia Canaria de Investigación, Innovación y Sociedad de la Información de la Consejería de Economía, Conocimiento y Empleo' and by the 'Fondo Social Europeo (FSE) Programa Operativo Integrado de Canarias 2014–2020, Eje 3 Tema Prioritario 74 (85%)'.

References

Angulo E, Caut S, Cerdá X (2011) Scavenging in Mediterranean ecosystems: effect of the invasive Argentine ant. Biological Invasion 13: 1183–1194. https://doi.org/10.1007/s10530-011-9953-6

Angulo E, Hoffmann BD, Ballesteros-Mejia L, Taheri A, Balzani P, Bang A, Renault D, Cordonnier M, Bellard C, Diagne C, Ahmed DA,Watari Y, Courchamp F (2022) Economic costs of invasive alien ants worldwide. Biological Invasions 24(7): 2041–2060. https://doi.org/10.1007/s10530-022-02791-w

Angulo E, Guénard B, Balzani P, Bang A, Frizzi F, Masoni A, Abril S, Suarez AV, Hoffmann B, Benelli G, Aonuma H, Lach L, Mothapo PN, Wossler T, Santini G (2024) The Argentine ant, *Linepithema humile*: natural history, ecology and impact of a successful invader. Entomologia Generalis 44: 41–61. https://doi.org/10.1127/entomologia/2023/2187

AntWeb (2023) Version 8.112. California Academy of Science. https://www.antweb.org. [Access: 16 September 2023]

Bellard C, Rysman JF, Leroy B, Claud C, Mace GM (2017) A global picture of biological invasion threat on islands. Nature Ecology & Evolution 1(12): 1862–1869. https://doi.org/10.1038/s41559-017-0365-6

Bertelsmeier C (2021) Globalization and the anthropogenic spread of invasive social insects. Current opinion in insect science 46: 16–23. https://doi.org/10.1016/j.cois.2021.01.006

Blight O, Thomas T, Jourdan H, Bichaton JY, Colindre L, Galkowski C (2023) Detection and early impacts of France's first established population of the little fire ant, *Wasmannia auropunctata*. Biological Invasions 26(3): 627–631. https://doi.org/10.1007/s10530-023-03218-w

Boase C (2014) *Lasius neglectus* (Hymenoptera: Formicidae) in the UK: status, impact and management. In: Proceedings of the 8th International Conference on Urban Pests. H-8200 Veszprém, Papái Ut. OOK-Press Kft, 223–228.

Boer P, Vierbergen B (2008) Exotic ants in the Netherlands (Hymenoptera: Formicidae) Entomologische berichten 68(4): 121–129.

Breton JL, Delabie JH, Chazeau J, Dejean A, Jourdan H (2004) Experimental evidence of large-scale unicoloniality in the tramp ant *Wasmannia auropunctata* (Roger). Journal of insect Behavior 17: 263–271. https://doi.org/10.1023/B:JOIR.0000028575.28700.71

Causton CE, Sevilla CR, Porter SD (2005) Eradication of the little fire ant, *Wasmannia auropunctata* (Hymenoptera: Formicidae), from Marchena Island, Galapagos: on the edge of success? Florida Entomologist 88(2): 159–168. https://doi.org/10.1653/0015-4040(2005)088[0159:EOTLFA]2.0.CO;2

Christian S (2009) Red imported fire ants eradicated from Napier. Bios 92: 28–29.

Conant P, Hirayama C (2000) *Wasmannia auropunctata* (Hymenoptera: Formicidae): established on the Island of Hawaii. Bishop Museum Occasional Papers 64(2): 21–22.

Davis NE, O'Dowd DJ, Mac Nally R, Green PT (2010) Invasive ants disrupt frugivory by endemic island birds. Biology Letters 6(1): 85–88. https://doi.org/10.1098/rsbl.2009.0655

Demetriou J, Georgiadis C, Roy H, Martinou A, Borowiec L, Salata S (2022) One of the world's worst invasive alien species *Wasmannia auropunctata* (Hymenoptera: Formicidae) detected in Cyprus. Sociobiology 69(4): e8536–e8536. https://doi.org/10.13102/sociobiology.v69i4.8536

Dlugosch KM, Parker IM (2008) Founding events in species invasions: genetic variation, adaptive evolution, and the role of multiple introductions. Molecular ecology 17(1): 431–449. https://doi.org/10.1111/j.1365-294X.2007.03538.x

Early R, Bradley BA, Dukes JS, Lawler JJ, Olden JD, Blumenthal DM, Gonzalez P, Grosholz ED, Ibañez I, Miller LP, Sorte CJB, Tatem AJ (2016) Global threats from invasive alien species in the twenty-first century and national response capacities. Nature communications 7(1): 12485. https://doi.org/10.1038/ncomms12485

Espadaler X, Pradera C, Santana JA (2018) The first outdoor-nesting population of *Wasmannia auropunctata* in continental Europe (Hymenoptera, Formicidae). Iberomyrmex 10: 1–8.

Fagua JC, Ackerman JD (2011) Consequences of floral visits by ants and invasive honeybees to the hummingbird-pollinated, Caribbean cactus *Melocactus intortus*. Plant Species Biology 26(3): 193–204. https://doi.org/10.1111/j.1442-1984.2011.00319.x

Foucaud J, Fournier D, Orivel J, Delabie JH, Loiseau A, Le Breton J, Kergoat GJ, Estoup A (2007) Sex and clonality in the little fire ant. Molecular biology and evolution 24(11): 2465–2473. https://doi.org/10.1093/molbev/msm180

Fournier D, Estoup A, Orivel J, Foucaud J, Jourdan H, Breton JL, Keller L (2005) Clonal reproduction by males and females in the little fire ant. Nature 435(7046): 1230–1234. https://doi.org/10.1038/nature03705

Fournier A, Penone C, Pennino MG, Courchamp F (2019) Predicting future invaders and future invasions. Proceedings of the National Academy of Sciences 116(16): 7905–7910. https://doi.org/10.1073/pnas.1803456116

Geiter O, Homma S, Kinzelbach R, von Biologie UDW (2002) Bestandsaufnahme und Bewertung von Neozoen in Deutschland.

Gobierno de Canarias (2024) Statistics. https://www.biodiversidadcanarias.es/biota/estadisticas?se=0&m=0 [access: November 11, 2024]

Gruber MA, Santoro D, Cooling M, Lester PJ, Hoffmann BD, Boser C, Lach L (2021) A global review of socioeconomic and environmental impacts of ants reveals new insights for risk assessment. Ecological Applications 32(4): e2577. https://doi.org/10.1002/eap.2577

Hansen DM, Müller CB (2009) Invasive ants disrupt gecko pollination and seed dispersal of the endangered plant *Roussea simplex* in Mauritius. Biotropica 41(2): 202–208. https://doi.org/10.1111/j.1744-7429.2008.00473.x

Heinze J, Cremer S, Eckl N, Schrempf A (2006) Stealthy invaders: the biology of *Cardiocondyla* tramp ants. Insectes sociaux 53: 1–7. https://doi.org/10.1007/s00040-005-0847-4

Hernández-Teixidor D, Pérez-Delgado A J, Suárez D, Reyes-López J (2020) Six new non-native ants (Formicidae) in the Canary Islands and their possible impacts. Journal of Applied Entomology 144(6): 434–441. https://doi.org/10.1111/jen.12751

Hoffmann BD (2010) Ecological restoration following the local eradication of an invasive ant in northern Australia. Biological Invasions 12(4): 959–969. https://doi.org/10.1007/s10530-009-9516-2

Hoffmann BD (2011) Eradication of populations of an invasive ant in northern Australia: successes, failures and lessons for management. Biodiversity and Conservation 20: 3267–3278. https://doi.org/10.1007/s10531-011-0106-0

Hoffmann B, Davis P, Gott K, Jennings C, Joe S, Krushelnycky P, Miller R, Webb G, Widmer, M (2011) Improving ant eradications: details of more successes, a global synthesis and recommendations. Aliens 31: 16–23.

Hoffmann BD, Luque GM, Bellard C, Holmes ND, Donlan CJ (2016) Improving invasive ant eradication as a conservation tool: A review. Biological Conservation 198: 37–49. https://doi.org/10.1016/j.biocon.2016.03.036

Holway DA, Lach L, Suarez AV, Tsutsui ND, Case TJ (2002) The causes and consequences of ant invasions. Annual review of ecology and systematics 33(1): 181–233. https://doi.org/10.1146/annurev.ecolsys.33.010802.150444

Holway D A, Cameron EK (2021) The importance of scavenging in ant invasions. Current Opinion in Insect Science 46: 39–42. https://doi.org/10.1016/j.cois.2021.01.007

Hsu P W, Lee CC, Hsu F C, Tseng SP, Shih CH, Tay JW,Yu-Chun H, Ching-Cheng SY, Lin CC (2022) Invasion of the little fire ant *Wasmannia auropunctata* (Roger, 1863)(Hymenoptera: Formicidae) in Taiwan. BioInvasions Records 11(4): 864–875. https://doi.org/10.3391/bir.2022.11.4.05

ISSG (2015) The Global Invasive Species Database. Version 2015.1. https://www.iucngisd.org/gisd/ [access: August 11, 2024]

Lawson Handley LJ, Estoup A, Evans DM, Thomas CE, Lombaert E, Facon B, Aebi A, Roy HE (2011) Ecological genetics of invasive alien species. BioControl 56: 409–428. https://doi.org/10.1007/s10526-011-9386-2

Lee DJ, Motoki M, Vanderwoude C, Nakamoto ST, Leung P (2015) Taking the sting out of Little Fire Ant in Hawaii. Ecological Economics 111: 100–110. https://doi.org/10.1016/j.ecolecon.2015.01.010

Lodge DM, Williams S, MacIsaac HJ, Hayes KR, Leung B, Reichard S, Mack R, Moyle P, Smith M, Andow D, Carlton J, McMichael A (2006) Biological invasions: recommendations for US policy and management. Ecological applications 16(6): 2035–2054. https://doi.org/10.1890/1051-0761(2006)016[2035:BIRFUP]2.0.CO;2

Longino JT, Fernández F (2007) Taxonomic review of the genus *Wasmannia*. Memoirs of the American Entomological Institute 80: 271–289.

Lopez DJ, Winkel KD, Wanandy T, van Nunen S, Perrett KP, Lowe AJ (2024) The human health impacts of the red imported fire ant in the Western Pacific Region context: A narrative review. Tropical Medicine and Infectious Disease 9(4): 69. https://doi.org/10.3390/tropicalmed9040069

Macom TE, Porter SD (1996) Comparison of polygyne and monogyne red imported fire ant (Hymenoptera: Formicidae) population densities. Annals of the Entomological Society of America 89(4): 535–543. https://doi.org/10.1093/aesa/89.4.535

Martinez B, Reaser JK, Dehgan A, Zamft B, Baisch D, McCormick C, Giordano A, Aicher R, Selbe S (2020) Technology innovation: advancing capacities for the early detection of

and rapid response to invasive species. Biological Invasions 22(1): 75–100. https://doi.org/10.1007/s10530-019-02146-y

Mikheyev AS, Bresson S, Conant P (2009) Single-queen introductions characterize regional and local invasions by the facultatively clonal little fire ant *Wasmannia auropunctata*. Molecular Ecology 18(14): 2937–2944. https://doi.org/10.1111/j.1365-294X.2009.04213.x

Montgomery MP, Vanderwoude C, Lintermans M, Lynch AJ (2022) The little fire ant (Hymenoptera: Formicidae): a global perspective. Annals of the Entomological Society of America 115(6): 427–448. https://doi.org/10.1093/aesa/saac016

Myers N, Mittermeier RA, Mittermeier CG, Da Fonseca GA, Kent J (2000) Biodiversity hotspots for conservation priorities. Nature 403(6772): 853–858. https://doi.org/10.1038/35002501

Paini D R, Sheppard AW, Cook DC, De Barro PJ, Worner SP, Thomas MB (2016) Global threat to agriculture from invasive species. Proceedings of the National Academy of Sciences 113(27): 7575–7579. https://doi.org/10.1073/pnas.1602205113

Passera L (1994) Characteristics of tramp species. In: Williams D (Eds) Exotic Ants: biology, impact and control of introduced species. Westview Press (Boulder Colorado): 23–43. https://doi.org/10.1201/9780429040795-3

Perrings C, Fenichel E, Kinzig A (2010) Globalization and invasive alien species: trade, pests, and pathogens. In: Perrings C, Mooney H, Williamson M (Eds) Bioinvasions and Globalization: Ecology, Economics, Management and Policy. Oxford University Press, (New York): 42–55. https://doi.org/10.1093/acprof:oso/9780199560158.003.0004

Plentovich S, Hebshi A, Conant S (2009) Detrimental effects of two widespread invasive ant species on weight and survival of colonial nesting seabirds in the Hawaiian Islands. Biological Invasions 11: 289–298. https://doi.org/10.1007/s10530-008-9233-2

Ratnasingham S, Hebert PD (2013) A DNA-based registry for all animal species: the Barcode Index Number (BIN) system. PloS one 8(7): e66213. https://doi.org/10.1371/journal.pone.0066213

Reaser JK, Meyerson LA, Cronk Q, De Poorter MA J, Eldrege LG, Green E, Kairo M, Latasi P, Mack R, Mauremootoo J, O´Dowd D, Orapa W, Sastroutomo S, Saunders A, Shine C, Thrinsson S, Vaiutu L (2007) Ecological and socioeconomic impacts of invasive alien species in island ecosystems. Environmental Conservation 34(2): 98–111. https://doi.org/10.1017/S0376892907003815

Reaser JK, Burgiel SW, Kirkey J, Brantley KA, Veatch SD, Burgos-Rodríguez J (2020) The early detection of and rapid response (EDRR) to invasive species: a conceptual framework and federal capacities assessment. Biological Invasions 22: 1–19. https://doi.org/10.1007/s10530-019-02156-w

Rey O, Facon B, Foucaud J, Loiseau A, Estoup A (2013) Androgenesis is a maternal trait in the invasive ant *Wasmannia auropunctata*. Proceedings of the Royal Society B: Biological Sciences 280(1766): 20131181. https://doi.org/10.1098/rspb.2013.1181

Rosselli D, Wetterer JK (2017) Stings of the ant *Wasmannia auropunctata* (Hymenoptera: Formicidae) as cause of punctate corneal lesions in humans and other animals. Journal of Medical Entomology 54(6): 1783–1785. https://doi.org/10.1093/jme/tjx167

Sinu PA, Sibisha VC, Nikhila Reshmi MV, Reshmi KS, Jasna TV, Aswathi K, Megha PP (2017) Invasive ant (*Anoplolepis gracilipes*) disrupts pollination in pumpkin. Biological invasions 19: 2599–2607. https://doi.org/10.1007/s10530-017-1470-9

Simberloff D (2003) Eradication-preventing invasions at the outset. Weed Science 51(2): 247–253. https://doi.org/10.1614/0043-1745(2003)051[0247:EPIATO]2.0.CO;2

Souza E, Follett PA, Price DK, Stacy EA (2008) Field suppression of the invasive ant *Wasmannia auropunctata* (Hymenoptera: Formicidae) in a tropical fruit orchard in Hawaii. Journal of Economic Entomology 101(4): 1068–1074. https://doi.org/10.1603/0022-0493(2008)101[1068:FSOTIA]2.0.CO;2

Schifani E, Gentile V, Scupola A, Espadaler X (2018) Yet another alien: a second species of *Lepisiota* spreading across the Canary Islands, Spain (Hymenoptera: Formicidae). Fragmenta entomologica 50(1): 61–64. https://doi.org/10.4081/fe.2018.287

Staab M (2019) *Plagiolepis alluaudi* Emery, 1894, a globally spreading exotic ant (Hymenoptera, Formicidae) newly recorded from Tenerife (Canary Islands, Spain). Journal of Hymenoptera Research 74: 83–91. https://doi.org/10.3897/jhr.74.47315

Stamatakis A (2014) RAxML version 8: a tool for phylogenetic analysis and post-analysis of large phylogenies. Bioinformatics 30(9): 1312–1313. https://doi.org/10.1093/bioinformatics/btu033

Suarez AV, McGlynn TP, Tsutsui ND (2010) Biogeographic and taxonomic patterns of introduced ants. In: Lach L, Parr CL, Abbott KL (Eds) Ant ecology. Oxford University Press (New York), 233–244. https://doi.org/10.1093/acprof:oso/9780199544639.003.0013

Suhr EL, O'Dowd DJ, Suarez A, Cassey P, Wittmann TA, Ross J, Cope RC (2019) Ant interceptions reveal roles of transport and commodity in identifying biosecurity risk pathways into Australia. NeoBiota 53: 1–24. https://doi.org/10.3897/neobiota.53.39463

Tercel MP, Cuff JP, Symondson WO, Vaughan IP (2023) Non-native ants drive dramatic declines in animal community diversity: A meta-analysis. Insect Conservation and Diversity 16(6): 733–744. https://doi.org/10.1111/icad.12672

Turner KL, Conner LM, Beasley JC (2021) Effects of red imported fire ant (*Solenopsis invicta*) control on carrion use by vertebrate scavengers. Food Webs 29: e00212. https://doi.org/10.1016/j.fooweb.2021.e00212

Ujiyama S, Tsuji K (2018) Controlling invasive ant species: a theoretical strategy for efficient monitoring in the early stage of invasion. Scientific Reports 8(1): 8033. https://doi.org/10.1038/s41598-018-26406-4

Vanderwoude C, Onuma K, Reimer N (2010) Eradicating *Wasmannia auropunctata* (Hymenoptera: Formicidae) from Maui, Hawaii: the use of combination treatments to control an arboreal invasive ant. Proceedings of the Hawaiian Entomological Society 42: 3–23.

Vanderwoude C, Montgomery M, Forester H, Hensley E, Adachi MK (2016) The history of little fire ant *Wasmannia auropunctata* Roger in the Hawaiian Islands: spread, control, and local eradication. Proceedings of the Hawaiian Entomological Society 48: 39–50.

Vonshak M, Dayan T, Ionescu-Hirsh A, Freidberg A, Hefetz A (2010) The little fire ant *Wasmannia auropunctata*: a new invasive species in the Middle East and its impact on the local arthropod fauna. Biological invasions 12: 1825–1837. https://doi.org/10.1007/s10530-009-9593-2

Wang H, Sui X, Wang X, Xiao J, Gao X, Wang H (2024) Invasion alert for *Wasmannia auropunctata*: a potential distribution in southern China and associated invasion risk to urban, rural, agricultural, and forest lands. Journal of Pest Science 97(2): 597–612. https://doi.org/10.1007/s10340-023-01694-6

Wetterer JK (2010) Worldwide spread of the pharaoh ant, *Monomorium pharaonis* (Hymenoptera: Formicidae). Myrmecological News 13: 115–129.

Wetterer JK (2012) Worldwide spread of the African big-headed ant, *Pheidole megacephala* (Hymenoptera: Formicidae). Myrmecological News 17: 51–62.

Wetterer JK (2013) Worldwide spread of the little fire ant, *Wasmannia auropunctata* (Hymenoptera: Formicidae). Terrestrial Arthropod Reviews 6(3): 173–184. https://doi.org/10.1163/18749836-06001068

Wetterer JK, Miller SE, Wheeler DE, Olson CA, Polhemus DA, Pitts M, Ashton IW, Himler AG,Yospin MM, Helms KR, Harken EL,Gallaher J, Dunning CE, Nelson M, Litsinger J, Southern A, Burgess TL (1999) Ecological dominance by *Paratrechina longicornis* (Hymenoptera: Formicidae), an invasive tramp ant, in biosphere 2. Florida Entomologist 82(3): 381–388. https://doi.org/10.2307/3496865

Wylie R, Jennings C, McNaught MK, Oakey J, Harris EJ (2016) Eradication of two incursions of the red imported fire ant in Queensland, Australia. Ecological Management & Restoration 17(1): 22–32. https://doi.org/10.1111/emr.12197

Yu DW, Ji Y, Emerson BC, Wang X, Ye C, Yang C, Ding Z (2012) Biodiversity soup: metabarcoding of arthropods for rapid biodiversity assessment and biomonitoring. Methods in Ecology and Evolution 3(4): 613–623. https://doi.org/10.1111/j.2041-210X.2012.00198.x

Zhou AM, Liang GW, Zeng L, Lu YY, Xu YJ (2014) Interactions between ghost ants and invasive mealybugs: the case of *Tapinoma melanocephalum* (Hymenoptera: Formicidae) and *Phenacoccus solenopsis* (Hemiptera: Pseudococcidae). Florida Entomologist 97(4): 1474–1480. https://doi.org/10.1653/024.097.0423

Supplementary material 1

Canarian checklist of ants

Authors: Antonio José Pérez-Delgado, Irene Santos-Perdomo, Eduardo Jiménez-García, David Lugo, Daniel Suárez

Data type: docx

Explanation note: The distribution of the species of ants present in the Canary Islands and their corresponding category of origin is indicated, as well as which are included in the list of invasive species of the IUCN and which were found in the area of presence of *Wasmannia auropunctata*.

Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0/). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.

Link: https://doi.org/10.3897/jhr.98.144997.suppl1